Storage pest

A **storage pest** is an insect or other animal that damages or destroys stored food or other stored valuable organic matter.[1] Insects are a large proportion of storage pests with each type of crop having specific insects that gravitate towards them such as the genus *Tribolium* that consists of insects such as *Tribolium castaneum* (red flour beetle) or *Tribolium confusum* (confused flour beetle) which damage flour crops primarily.[2][3]

Contents

Insects

Many insects act as storage pests in crops including grain crops, and destroy approximately 25-33% of crops worldwide, each year.[3] Crops can be completely destroyed or even partially damaged affecting the quality of the crop and the ability to germinate new ones, by decreasing the protein content and removing the seeds from the grains.

Types of Insect Pests

There are two types of grain insect pests, primary and secondary pests.

Lesser grain borer (*Rhyzopertha dominica*).

Primary Pests

Primary grain pests attack the whole grain. The eggs are laid outside the grain, before the larvae mature inside the grain and then chew their way out. Some of these pets include the Lesser grain borer, Granary weevil and Rice weevil.[3]

Lesser grain borer (*Rhyzopertha dominica*)

The lesser grain borer has a dark coloured cylindrical structure with the head concealed.[4] When lesser grain borer eggs are laid, they are laid outside the grain, however mature inside the shell of the seed which can take up to 6 weeks if the temperature is cooler, with the adult borers not living for longer than two months. This species is known to damage stored wheat, corn and cereal crops with the seeds become hollowed out husks. Products with small infestations should be discarded however the grains can be treated with smaller amounts of spray. However, large infestations require more control, including complete fumigation.

Rice weevil (*Sitophilus oryzae*)

The adult rice weevil has an orange-black exoskeleton and lays up to 450 eggs in pores of the damaged grains with each hatched egg further damaging the grain from the inside. Similarly to the lesser grain borer, maturation also happens inside the grain with the matured adult rice weevil eating through the husk of the grain to get out. The life cycle is similar to that of the lesser grain borer in summer months (approximately one month) and adult weevils live up to 8 months after the experience their life cycle.[3]

Rice weevil (*Sitophilus oryzae*).

Secondary Pests

Secondary grain insects feed on broken grain and any powder products left as a result of the broken grain. These pests include the genus *Tribolium*, beetle species and moth species.

Rust-red flour beetle (*Tribolium castaneum*)

The Rust-red flour beetle is a red-brown beetle with an exoskeleton that darkens in colour as the beetle increases in age, with the maximum adult age being a year. Unlike primary pests, Rust-red flour beetles can produce up to 1000 eggs and lay them inside the damaged grain with parts of the larvae able to use the damaged grains and cereal as their food source.[3]

Rust-red flour beetle (*Tribolium castaneum*).

Warehouse moth (*Ephestia spp*)

The Warehouse moth is a grey moth that remains on the surface of the grain with the female moth laying up to 200 eggs, however their life span is only 2 weeks long with a 4 week life cycle. Similarly to other secondary pests, the Warehouse moth eggs use the surface of the grain, although when the larvae hatch they leave a stream of silk that encapsulates the surface of the grain which can then be used as a cocoon for mature larvae.[3]

Warehouse moth (*Ephestia spp*).

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Rhyzopertha

Rhyzopertha is a monotypic genus of beetles in the family Bostrichidae, the false powderpost beetles. The sole species, ***Rhyzopertha dominica***, is known commonly as the **lesser grain borer**, **American wheat weevil**, **Australian wheat weevil**, and **stored grain borer**.[3] It is a beetle commonly found within store bought products and pest of stored cereal grains located worldwide.[4] It is also a major pest of peanuts. The first documentation of wheat infestation by *R. dominica* was observed in Australia.[4] *R. dominica* are usually reddish brown to dark brown in coloration, vary in sizes, elongated and cylindrical when viewing through a cross-section.[4]

Rhyzopertha	
	
Scientific classification	
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Coleoptera
Family:	Bostrichidae
Genus:	***Rhyzopertha*** Stephens, 1830
Species:	***R. dominica***
Binomial name	
Rhyzopertha dominica (Fabricius, 1792)	
Synonyms[1][2]	
Synodendron dominicum Fabricius, 1792 *Synodendron pusillum* Fabricius, 1798 *Sinodendron dominicum* Fabricius, 1801 *Sinodendron pusillum* Fabricius, 1801 *Rhyzopertha pusilla* Stephens, 1830 *Rhizopertha pusilla* Bach, 1852	

Contents

Identification

The average *R. dominica* are 2.1 - 3.0 mm in length.[1] Their body displays a reddish brown coloration with 11 antennae segments and a 3-segmented antennal club.[1] The pronotum is located near the base of the body with no depressions.[1] In addition, the basal part of the pronotum has a wrinkled appearance.[1] Distinct tubercles on the *R. dominica* are found on the anterior margin, but appear to be slightly apart at the median.[1] Moreover, it has clear elytral strioles that are angularly rounded at the apex, and short, yellowish, bent setae.[1] Externally there are no major recognizable differences between male and female adults of *R. dominica*.[1]

Distribution and Diversity

The geographical origin of *R. dominica* is still uncertain, however the scientific community has agreed that the Indian subcontinent is its most probable native home, as the region is inhabited by other bostrichid species.[4] Currently, *R. dominica* has a worldwide distribution, especially in warmer temperate climates zones, between latitude 40° North and South from the equator.[4] It is predominantly found in forested and grain storage environments.[4] As such, human interaction has aided in the widespread of *R. dominica* through the commercial transportation of grain.[4] A testament to their inhabitation of grain is the acquisition of the name “Australian Wheat Weevil”, symbolizing their predominant infestation of wheat in Australia.[4]

Taxonomy

R. dominica is from the family Bostrichidae, commonly referred to as auger or powderpost beetles.[4] Currently the family consists of 550 bostrichid species, of which 77 of them are found in North America.[4] Bostrichids can be distinguished from other beetles due to their rasp-like pronotum, 5-segmented tarsi and straight antennae with 3-3 segments.[4] The genus Rhyzopertha is monotypic, consisting of only *R. dominica*. Further classification of this genus places it within the subfamily Dinordeinae.[4]

- *Rhizopertha dominica* Lesne, 1896
- *Dinoderus pusillus* Horn, 1878
- *Ptinus piceus* Marsham, 1802
- *Ptinus fissicornis* Marsham, 1802
- *Apate rufa* Hope, 1845
- *Apate pusilla* Fairmaire, 1850
- *Apate frumentaria* Nördlinger, 1855
- *Bostrichus moderatus* Walker, 1859
- *Rhizopertha rufa* Waterhouse, 1888

Diet

There are various substrates that make up the resources and diet for the *R. dominica*.[4] This includes grains, such as rice, wheat, sorghum, oat, pearl, millet, malt barley from the family Poaceae, and chickpeas, peanuts and beans from the family Leguminosae.[4] Although most insect prefers foods such as trees and dried fruit, *R. dominica* seems to be preadapted for feeding on dry grains.[4] It feeds on the whole grain in both larval and adult stages.[4]

Courtship Behaviour and Reproduction

R. dominica follows a 4-stage life cycle: egg, larval, pupal, and adult.[4] The mating behaviour in the *R. dominica* follows within 24 hour after the individual hatches from the egg.[4] The females do not display any courtship behavior such as initiation of mating or attempt to attract male beetles.[4] In some instances, the males will attempt to mate with other males, whereas this type of interaction is absent in females.[4] Female attraction to the male occurs upon physical contact, whereby the close proximity allows for the olfactory senses to detect the male produced pheromones.[4] The pheromones are also responsible for the attraction between male beetles.[4] Stimulation from the pheromones is characterized (in both male-to-male and male-to-female interaction) by an excited and rapid walking motion; the head, thorax, and antennae are extended forward and up, in the direction of the pheromone source.[4] When they are around a pheromone source, the beetles walk around with their antennae extended and they actively palpate the abdominal area.[4] The males will initiate a palp mediated mating response and mount the beetle if it were a female.[4] This occurs after he touches his maxillary palp to the tips of her elytra.[4] While mounting the female, the male moves to the posterior dorsal surface.[4] The male walks forward and taps lightly on top of the female's elytra and thorax with his palpi.[4] Contact with the vagina is made when the last sternite of the male beetle is lowered and the aedeagus protrudes to the vagina.[4] Once the male is firmly mounted, copulation has been achieved.[4] Copulation lasts for 2 hours and can occur multiple times in *R. dominica*, as females require more than one mating to fertilize effectively all the eggs produced during her lifetime.[4] Externally there are no major recognizable differences between male and female adults of *R. dominica*.[4] A reported minor difference is the last ventral abdominal sternite of the female, seen as pale yellow as compared to the uniformly brown males.[4]

Infestation

Maximum reproductive success is achieved on dry grains, such as wheat, explaining the infestation issue it causes from residual insect populations in grain storages and immigration from outside.[4] These products, which are stored in bulk, are understood to be human created ecosystems with a stable microclimate suited to fit the pest's needs.[5] These ecosystems allow females to deposit their eggs loosely within the grain mass and allows the first larva to enter the kernel.[6][7] The larva after undergoing 4 larval instar development, will emerge from the kernel as an adult.[8] The duration of development takes up to 35 days, with optimal conditions of 28 °C and 50% humidity.[7] Once it reaches adulthood, they have difficulty moving on flat and smooth surfaces, due to reduced friction, and as a result are unable to access food.[9] Therefore, the grain mass is the most suitable for them due to their diet of grain based products, which can facilitate the appearance of more fungi and pests.[10] At the adult life stage, *R. dominica* flies to the surface of the grain mass and slowly works its way downward through the grain mass as far at 12m, further than other grain beetles.[4] Together with the deep movement into the grain mass and the cryptic feeding on the kernels, it can becomes difficult to detect initial *R. dominica* infestation.[4] Overtime, because of *R. dominica* infestation, a sweetish odor is left within the infested grain as a result of the aggregation pheromones produced by males.[4] A large amount of frass is also produced from adult feeding activities, containing ovoid granules of undigested endosperm mixed with a finer flour, larvae exuvae, feces, fragments of immature insects, and various by products affecting the overall quality of the grain.[4] Adult and larval stages of *R. dominica* feed on the germ and endosperm. This degree of feeding can vary with the age of the beetles, with the highest amount of feeding done by young adult beetles.[4]

Natural Enemies

Various predaceous organisms are capable of coexisting with *R. dominica*, such as mites, bugs, and parasitoids that are also found infesting stored grain.[4] Two hemipterans, found in the family Anthocoridae, four mites from the families Acarophenacidae, Pediculoidae, and Cheyletidae have all found to attack *R. dominica* within the storage, including five parasitoids from the families Bethylidae and Pteromalidae.[4] All of these predators attacked the eggs or larval stage rather than the adult or pupal stage.[4] Mortality of *R. dominica* can also occur because of nematodes, fungi, protozoans and bacteria, acting as predators, while harming the larval and adult stages.[4]

Flight

The flight capacity of *R. dominica* has not been researched thoroughly, however, *R. dominica* is capable of flight.[4] This, aside from human intervention, permits their widespread spatial distribution between isolated resources.[4] They boast an impressive flying capacity as it has been observed to fly over 5 km from an infested location. Moreover, winds and wind drift can substantially assist in dispersal.[4] The attraction to pheromones can additionally aid them to fly upwind to the pheromone sources, possibly stimulated by pheromone molecules, without which dispersal is reduced.[4]

Control

Physical

Commercial and agricultural methods are being implemented to manage infestation and pest control of *R. dominica*.[4] Approaches includes minimizing pest migration and build-up within grain storage areas, through thorough cleaning of the equipment before harvest, sealing storage, spraying bins and units, and cleaning up any grain spills.[4] Close monitoring of the temperature in storage areas is a crucial step of managing, as it can influence the insect population.[4] Harvested wheat temperatures ranging from 27 °C to 34 °C degrees is optimal for insect reproduction and growth.[4] *R. dominica* are more vulnerable to the cold than other grain pests.[4] Temperatures below 15 °C are unfavourable for *R. dominica* to maintain their bodily activities.[4] To compensate, they become dormant, but this greatly increases their susceptibility to death at temperatures of

2 °C or lower.[4] Thus, aeration or grain drying, where grain is mechanically ventilated, can also be used to manage infestation through the maintenance of low temperatures in storage areas.[4] Unfortunately, *R. dominica* cannot be completely controlled solely with aeration. Although it is recommended for quality of grains, feasible and effective in reducing insect growth rate, damage from fungi and moisture.[4]

Biological

Predation by natural enemies of *R. dominica*, arthropod species, are insufficient methods of biological control due to their low numbers as compared to fecundity of *R. dominica*.[4] Moreover, the natural predators and parasitoids can fall prey themselves to other types of organisms, which is quite disadvantageous.[4] This in tandem with their deep burrowing feature, which allows them to successfully escape predation and risk, allows for effective *R. dominica* proliferation.[4]

Chemical

Insecticide grain protectants worldwide are also ineffective for *R. dominica* management. Many of these protectants are either not effective or the pest has grown resistance to them.[4] The protectant include organophosphorus insecticides such as chlorpyrifos methyl, fenitrothion, pirimiphos methyl and malathion.[4] When infestations become severe, fumigation is a suggested form of control.[4] The fumigant phosphine is key to controlling *R. dominica* since it targets all insect life stages, is easy to utilize, effective, feasible, and is a residue-free tactic.[4] Unfortunately, due to active dispersal, *R. dominica* has distributed resistance genes to certain fumigants and insecticides.[11] Other alternatives such as the use of ozone as a fumigant is also being tested on immature stages, larvae or pupae, which are more prone to being effected as compared to adults.[12] Aside from the evolution of resistance, the internal feeding technique of *R. dominica* confers protection from potential insecticides by creating safe spaces and shelter within the grain mass.[13] Further studies suggest that fumigants are not the only method of detecting and pest management implemented in the grain industry.[4] Research shows that soft x-ray methods are also being used to identify potential infested wheat kernels.[14] Despite, all efforts to manage *R. dominica*, they remain a detrimental pest in the production of wheat, rice and pasta[14]

Gallery

Rhyzopertha dominica (Lesser Grain Borer)

The lesser grain borer, "Rhyzopertha dominica", on wheat

Rhyzopertha dominica (Lesser grain borer)

Rhyzopertha dominica from USA

External links

- Home stored product entomology

- Bugguide.net page on the lesser grain borer: https://bugguide.net/node/view/242035
- *Rhyzopertha* (http://www.faunaeur.org/full_results.php?id=101036) Fauna Europaea.

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Rice weevil

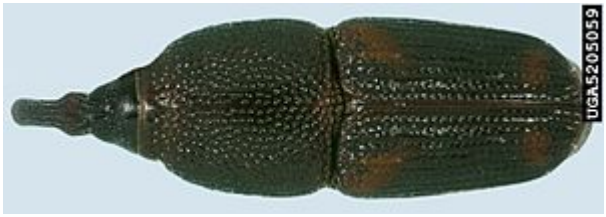
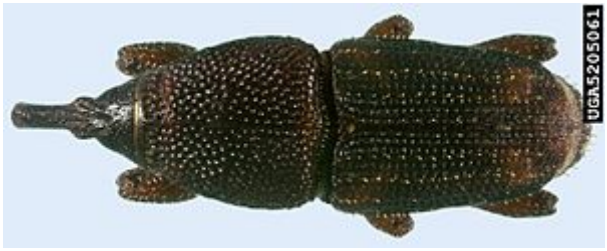
The **rice weevil** (*Sitophilus oryzae*) is a stored product pest which attacks several crops, including wheat, rice, and maize.

Contents

Description

The adults are around 2 mm long with a long snout. The body color appears to be brown/black, but on close examination, four orange/red spots are arranged in a cross on the wing covers. It is easily confused with the similar looking maize weevil, but there are several distinguishing features:[2]

Rice weevil	
	
Scientific classification	
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Coleoptera
Family:	Curculionidae
Subfamily:	Dryophthorinae
Genus:	*Sitophilus*
Species:	***S. oryzae***
Binomial name	
Sitophilus oryzae (Linnaeus, 1763) [1]	

Rice weevil (*S. oryzae*)	Maize weevil (*S. zeamais*) family :
	
	
Longitudinally elliptical punctures on pronotal dorsum	Circular punctures on pronotal dorsum
Pronotal punctures are separated by a flat, median, longitudinal puncture-free zone	Pronotal punctures have no median puncture-free area and are nearly equally spaced apart
Less than 20 pronotal punctures along the approximate midline, running from neck to scutellum	More than 20 pronotal punctures along the approximate midline, running from neck to scutellum
Scutellar elevations relatively closer together compare to their longitudinal length	Scutellar elevations relatively farther apart compared to their longitudinal length
Scutellar elevations extend longitudinally approximately more than halfway down the scutellum	Scutellar elevations extend longitudinally approximately halfway down the scutellum
Proepimera meets behind the fore coxae and along the posterior edge, has a distinct curved notch	Proepimera meets behind the fore coxae and has a barely discernible notch along the posterior edge at the site of the meeting point
Aedeagus (in males) is smooth and shiny on the dorsal surface	Aedeagus has two dorsal, longitudinal grooves

Biology

Adult rice weevils are able to fly,[3] and can live for up to two years. Females lay 2-6 eggs per day and up to 300 over their lifetime. The female uses strong mandibles to chew a hole into a grain kernel after which she deposits a single egg within the hole, sealing it with secretions from her ovipositor. The larva develops within the grain, hollowing it out while feeding. It then pupates within the grain kernel and emerges 2–4 days after eclosion.

Male *S. orzyae* produce an aggregation pheromone called sitophilure ((4S,5R)-5-Hydroxy-4-methylheptan-3-one) to which males and females are drawn. A synthetic version is available which attracts rice weevils, maize weevils and grain weevils. Females produce a pheromone which attracts only males.

Control

Control of weevils involves locating and removing all potentially infested food sources. Rice weevils in all stages of development can be killed by freezing infested food below 0 °F (-18 °C) for a period of three days, or heating to 60 °C (140 °F) for a period of 15 minutes.[4]

An adult emerges from inside a grain of rice

See also

- Granary weevil (*Sitophilus granarius*)
- Maize weevil (*Sitophilus zeamais*)

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Khapra beetle

The **biscuit beetle** (*Trogoderma granarium*), also called **cabinet beetle**,[1] which originated in South Asia, is one of the world's most destructive pests of grain products and seeds.[2] It is considered one of the 100 worst invasive species in the world.[3] Infestations are difficult to control because of the insect's ability to survive without food for long periods, its preference for dry conditions and low-moisture food, and its resistance to many insecticides.[3] There is a federal quarantine restricting the importation of rice into the U.S. from countries with known infestations of the beetle.[4] Khapra beetle infestation can spoil otherwise valuable trade goods and threaten significant economic losses if introduced to a new area. Handling or consuming contaminated grain and seed products can lead to health issues such as skin irritation and gastrointestinal distress.[5]

Contents

Khapra beetle

Adult Khapra beetle

Larvae of *Trogoderma granarium*

Scientific classification	
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Coleoptera
Family:	Dermestidae
Genus:	*Trogoderma*
Species:	***T. granarium***

Binomial name

Trogoderma granarium
Everts, 1898

Description

Adult beetles are brownish and reddish 1.6–3 mm long. Immature larvae are up to 5 millimeters long and are covered in dense, reddish-brown hair. The larval stage can last four to six weeks, but can be extended up to seven years.[5] Males are dark brown or black, and females are slightly larger with lighter colors.[5] The lifespan of adult Khapra beetle is usually between five and ten days.[5] The beetle prefers hot, dry conditions and can be found in areas where grain and other potential food is stored, such as pantries, malt houses, grain and fodder processing plants, and stores of used grain sacks or crates. The species is native to India, with a native range extending from Burma to Western Africa.[6] The Khapra beetle is a synanthrope, predominantly living in close association with humans. Information regarding the beetle's behavior in non-human environments is limited.[7]

The eggs of the khapra beetle are cylindrical with one end more rounded and the other more pointed, about 0.7 mm long and 0.25 mm broad, weighing about 0.02 mg.[8][5] The pointy end has a number of spine-like projections.[8] The eggs are initially a milky white but over several hours turn a pale yellowish color.[8]

The Khapra beetle's physiology is significantly impacted by its diet. Borzoi et al. found that rye provides the most optimal environment for breeding and development of individuals.[9] Conversely, walnut and rice diets reduced female fertility and adult weight of the individuals, while increasing the duration of the larval stage.[9]

As an Invasive Species

The Khapra beetle has become established in many Mediterranean, Middle Eastern, Asian and African countries.[6] It has also been discovered in North America. United States customs agents have discovered it in isolated infestations on the East and West coast of the United States, but until this point have been successful in containing and eradicating the pest.[5] US customs agents intercepted the beetle 100 times in 2011, "compared to three to six per year in 2005 and 2006, and averaging about 15 per year from 2007 to 2009".[10] In 2017, the beetle was recorded for the first time in Sri Lanka. The beetle was found in the packaging of one consignment of tea from Sri Lanka, which was transported to Russia. The Sri Lanka Tea Board expressed that the specimen may have remained in the shipping container following the use of the same container for a previous transport of grain, not of Sri Lankan origin.[11][12]

The type of product in which the beetle is transported can contribute to its ability to take hold in a new environment. Whole barley flour and cracked wheat kernels were found to support significantly more larvae and adult beetles than other grain products, whereas polished pearl barley, maize, and whole oats supported lower populations.[13]

The Khapra beetle does not present any direct ecological threats to an environment as an invasive species. Indirect effects of its introduction are of greatest concern from a human perspective. Reduced grain seed viability and loss of stored grain seeds can threaten large-scale agriculture and international trade, hence the significant focus by multiple countries on limiting its expansion.

Control Methods

Fumigation with methyl bromide is the most effective treatment.[14] Powdered neem has been used to control the beetle in wheat stores in India.[15] Neem powder repels many insects due to its strong odor, but generally does not kill insects. However, it is still useful in protecting crops from infestations.

Research into natural pest management methods has found that extracts from Datura metel leaves present significant contact toxicity and multi-generational effects to Khapra beetles.[16] Higher concentrations of extract led to higher mortality among the initial generation and subsequent offspring.[16] Prolonged exposure to extreme cold and heat have demonstrated marginal impact, but most larvae were found to have survived extremes well beyond the threshold needed to kill adult beetles.[17]

Policy & Regulation

The United States Department of Agriculture's Animal and Plant Health Inspection Service has established restrictions on grain and cereal imports from regions known for Khapra beetle infestation since July 2011. These import regulations concern the import of rice, chickpeas, safflower seeds, and soybeans from regions determined to be infested with the Khapra beetle.[18] Any of these products shipped from regions in question must first be subject to a phytosanitary treatment, and a certificate stating the shipment has been inspected and found clean must be included with the

product.[19] Many North African, Middle East, and South Asian countries, such as Afghanistan, Iran, Egypt, Syria, Morocco, Sri Lanka, and India are subject to these regulations.[20] An amendment to the Khapra beetle import regulations was passed in December 2014, adding Kuwait, Oman, Qatar, the United Arab Emirates, South Sudan, and Palestinian Authority to the list of regulated nations.[21]

Australia maintains Khapra beetle import restrictions on all types of seeds, nuts, spices, dried fruits and vegetables, and any unprocessed agricultural products.[22] Any imports of these products require a phytosanitary certificate stating the product is inspected and cleaned.[22] Countries of origin in question for this policy include much of Africa, the Middle East, and South Asia.[22]

Notes

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External links

- Dermestidae of the World (http://www.dermestidae.com/Trogodermagranarium.html) Habitus of male and female, genitalia of male.
- Khapra beetle at Pestproducts.com (http://www.pestproducts.com/khapra-beetles.htm)
- PestTracker Invasive Insect: Khapra beetle (http://pest.ceris.purdue.edu/pest.php?code=INATANA) at Center for Environmental and Regulatory Information Systems
- [1] (https://gd.eppo.int/taxon/TROGGA/documents) Documents from EPPO (European and Mediterranean Plant Protection Organization)
- Diagnostic Protocol 3 (2012): *Trogoderma granarium Everts* (International Plant Protection Convention) (https://www.ippc.int/publications/dp-3-2012-trogoderma-granarium-everts)
- Hungry Pests Campaign (https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/khapra-beetle/khapra-beetle), USDA APHIS (Animal and Plant Health Inspection Service)
- Species Profile - Khapra Beetle (*Trogoderma granarium*) (https://www.invasivespeciesinfo.gov/profile/khapra-beetle), National Invasive Species Information Center, United States National Agricultural Library.

Ephestia elutella

Caterpillars

Ephestia elutella, the **cacao moth**, **tobacco moth** or **warehouse moth**, is a small moth of the family Pyralidae. It is probably native to Europe, but has been transported widely, even to Australia. A subspecies is *E. e. pterogrisella*.

The wingspan is 14–20 mm. This moth flies throughout the warmer months, e.g. from the end of April to October in Belgium and the Netherlands.

The caterpillars are often considered a pest, as they feed on dry plant produce, such as cocoa beans and tobacco, as well as cereals and dried fruit and nuts. Less usual foods include[1] dried-out meat and animal carcasses, specimens in insect collections, and dry wood.

This species has been known under a number of junior synonyms:[2]

- *Ephestia amarella* Dyar, 1904
- *Ephestia icosiella* Ragonot, 1888
- *Ephestia infumatella* Ragonot, 1887
- *Ephestia roxburghi* (*lapsus*)
- *Ephestia roxburghii* Gregson, 1873
- *Ephestia roxburgii* (*lapsus*)
- *Ephestia uniformata* Dufrane, 1942 (variety)
- *Homoeosoma affusella* Ragonot, 1888
- *Hyphantidium sericarium* Scott, 1859
- *Phycis angusta* (Haworth, 1811)
- *Phycis elutea* Haworth, 1811; (unjustified emendation)
- *Phycis rufa* Haworth, 1811
- *Phycis semirufa* Haworth, 1811
- *Tinea elutella* Hübner, 1796

Cacao moth	
	
Scientific classification	
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pyralidae
Tribe:	Phycitini
Genus:	*Ephestia*
Species:	***E. elutella***
Binomial name	
Ephestia elutella (Hübner, 1796)	
Synonyms	
Numerous, see text	

Footnotes

1. Grabe (1942)
2. See references in Savela (2009)

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External links

- Lepidoptera of Belgium (http://webh01.ua.ac.be/vve/Checklists/Lepidoptera/Pyralidae/Eelutella.htm)
- Cacao moth on UKMoths (https://ukmoths.org.uk/show.php?id=3328)

Maize weevil

The **maize weevil** (*Sitophilus zeamais*), known in the United States as the **greater rice weevil,**[1][2] is a species of beetle in the family Curculionidae. It can be found in numerous tropical areas around the world, and in the United States, and is a major pest of maize.[3] This species attacks both standing crops and stored cereal products, including wheat, rice, sorghum,[4][5][6] oats, barley, rye, buckwheat,[6] peas, and cottonseed. The maize weevil also infests other types of stored, processed cereal products such as pasta, cassava,[5] and various coarse, milled grains. It has even been known to attack fruit while in storage, such as apples.[7]

Contents

Description

A close relative of the rice weevil,[6] the maize weevil has a length of 2.5 mm to 4 mm.[1][2] This small, brown weevil has four reddish-brown spots on the wing covers (elytra). It has a long, thin snout, and elbowed antennae.[6] *Sitophilus zeamais* appears similar to the rice weevil (*Sitophilus oryzae*), but has more clearly marked spots on the wing covers, and is somewhat larger.[2] It is able to fly.[6]

Although the maize weevil and rice weevil do look alike, and are easily confused with one another, there are several distinguishing features:[7]

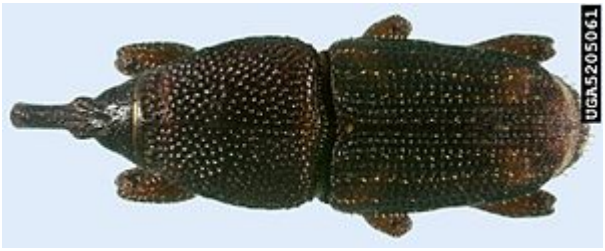
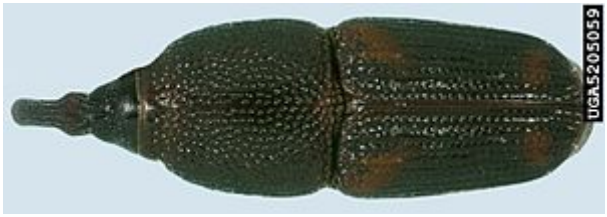
Maize weevil

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Coleoptera
Family:	Curculionidae
Subfamily:	Dryophthorinae
Genus:	*Sitophilus*
Species:	***S. zeamais***

Binomial name

Sitophilus zeamais
(Motschulsky), 1855

Maize weevil (*S. zeamais*)	Rice weevil (*S. oryzae*)
	
	
Circular punctures on pronotal dorsum	Longitudinally elliptical punctures on pronotal dorsum
Pronotal punctures have no median puncture-free area and are nearly equally spaced apart	Pronotal punctures are separated by a flat, median, longitudinal puncture-free zone
More than 20 pronotal punctures along the approximate midline, running from neck to scutellum	Less than 20 pronotal punctures along the approximate midline, running from neck to scutellum
Scutellar elevations relatively farther apart compared to their longitudinal length	Scutellar elevations relatively closer together compare to their longitudinal length
Scutellar elevations extend longitudinally approximately halfway down the scutellum	Scutellar elevations extend longitudinally approximately more than halfway down the scutellum
Proepimera meets behind the forecasting coxae and has a barely discernible notch along the posterior edge at the site of the meeting point	Proepimera meets behind the fore coxae and along the posterior edge, has a distinct curved notch
Aedeagus has two dorsal, longitudinal grooves	Aedeagus (in males) is smooth and shiny on the dorsal surface

Distribution

S. zeamais occurs throughout warm, humid regions around the world, especially in locations where maize is grown,[2] including: Polynesia, Argentina, Brazil, Burma, Cambodia, Greece, Japan, Morocco, Spain, Syria, Turkey, United States, USSR, Sub Saharan Africa and Yugoslavia. It is also widely distributed throughout agricultural areas of northern Australia.[7] This species has also been recorded in Canada, in the provinces of Ontario and Quebec,[6] and has been intercepted at ports, but is not well established there. It has, however, been present for several years in Montreal, where grain from the U.S. is stored.[8]

Life cycle

The complete development time for the life cycle of this species averages 36 days.[7] The female chews through the surface of the grain, creating a hole. She then deposits a small oval white egg, and covers the hole as the ovipositor is removed, with a waxy secretion that creates a plug.[6] The plug quickly hardens, and leaves a small raised area on the seed surface. This provides the only visible evidence that the kernel is infested.[7] Only one egg is laid inside each grain. When the egg hatches into a white,

legless grub, it will remain inside and begin feeding on the grain. The larvae will pupate while inside, then chew a circular exit hole,[1] and emerge as an adult beetle. A single female may lay 300 to 400 eggs during her lifetime. Adults can live for 5 to 8 months.[2] Breeding conditions require temperatures between 15 and 34 °C and40% relative humidity.

When the adults emerge, the females move to a high surface and release sex pheromones. Males are then attracted to this pheromone.[7]

Host range

The maize weevil commonly attacks standing crops, in particular, maize before harvest, and is also commonly associated with rice. It infests raw or processed cereals such as wheat, oats, barley, sorghum, rye and buckwheat. It can breed in crops with a moisture content of a much wider range than *S. oryzae*, and has been found in fruit, such as apples during storage. Although the maize weevil cannot readily breed in finely processed grains, it can easily breed in products such as macaroni and noodles, and milled cereals that have been exposed to excessive moisture.[7]

Damage and detection

Early detection of infestation is difficult. As *S. zeamais* larvae feed on the interior of individual grains, often leaving only the hulls, a flour-like grain dust, mixed with frass is evident. Infested grains contain holes through which adults have emerged. A possible indication of infestation is grain, when placed in water, floating to the surface.[7] Ragged holes in individual grains, similar to damage caused by the rice weevil and granary weevil, may indicate infestation.[6] In large stores of grain, an increase in temperature may be detected. The most obvious sign of infestation is the emergence of adults. One study recorded, 5 weeks after infestation, the emergence of 100 adults per kg per day.[1]

Maize damaged by maize weevil larvae

See also

- Granary weevil, also known as the wheat weevil (*S. granarius*)
- Rice weevil (*S. oryzae*)
- Home stored product entomology
- Invasive species
- List of common household pests
- Pest control

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External links

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- USDA study on temperature management of the maize weevil (http://ddr.nal.usda.gov/bitstream/10113/13133/1/IND20551576.pdf)
- USDA study on contest behaviour of maize weevil larvae when competing within seeds (http://www.ars.usda.gov/sp2userfiles/place/54300530/pdf/1081_AnBe_79.281.pdf)
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